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February 2, 2016

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Environmental Restoration, LLC.
1666 Fabick Drive
Fenton, MO 63062

Attention: Todd Conley

Reference: ERRS Region 2 WL2-26
Treatability Study
RFQ # WL2-26-04MB

Dear Todd;

The following is our report detailing the findings of a treatability study using different media for the reduction of lead in water discharging from the Wurtsboro Mine in Wurtsboro, NY.

Treatability Study Methodology

Approximately 40 gallons of water was collected from the discharge of the mine on Wednesday December 16, 2015. The water was transported back to our laboratory in Wharton, NJ where it was placed into a larger container and sealed at the top except for a small hole for the pump suction tubing.

Three different media were tested by placing the media in a clear PVC tube. A dutch weave screen was placed in the bottom of the tube to keep the media within the tube. A needle valve was placed in the bottom to regulate the effluent flow rate.

Chemical metering pumps were used to convey the water to the top of the tube. The flow rate into to the tube was matched to the flow rate out and the media was kept saturated during the entire test with the operating water level within the tube several inches above the media at all times. The water was collected in a 1,000 ml glass beaker and the total volume that passed through the media recorded as samples were collected.

A 1" diameter tube was used for the #16/60 limestone and Activated Alumina while a 2" diameter pipe was used for the 3/8" limestone (to reduce side wall effects).

Testing for the 3" limestone was completed in the field. A 55 gallon plastic drum was used with an internal screen to elevate the media off the bottom of the drum by several inches. A 1" inlet was

installed below the screen and a 1” outlet was installed several inches below the top. The drum was filled with approximately 30” of the 3” limestone rock. In this configuration the flow through the media was up flow, entering the bottom while exiting the top, to ensure the media was full saturated at all times. A small sump pump with a flow rate of approximately 3.75 gpm was set up at the face of the mine portal to move the water through the drum.

Activated Alumina was used as one of the test media. This media was used based upon published reports that this media was able to reduce lead in water. The Activated Alumina was sourced from SORBEAD India.

Fine grained limestone was used as another test media. This media was used based upon published reports of its ability to reduce lead in water. This media has the general characteristics of 100 percent passing the #16 (1.19 mm) sieve while 100% is retained on the # 60 (0.25) sieve. This media was sourced from the Carver Stone in Schoharie NY located approximately 100 miles from Wurtsboro, NY

3/8” limestone was used as the third media tested. This media was sourced from the Tilcon Rock Quarry in Oxford, NJ located approximately 70 miles from Wurtsboro. This media was tested because the concern over the physical size and low permeability of the 16/60 media.

3” limestone was used as the 4th media tested. This media was sourced from the Tilcon Rock Quarry in Oxford, NJ located approximately 70 miles from Wurtsboro.

Treatability Test Results

The untreated water had a pH of 5.77 and a total lead concentration of approximately 500 ppb. The dissolved component was 475 ppb indicating that the majority of the lead is dissolved in the water.

The results of the treatability study are presented in the chart below and are summarized as follows;

1. The **Activated Alumina** was able to reduce the lead concentration in the water from 536 ppb to as low as 9.18 ppb; however, the reduction efficiency was reduced as the testing progressed so that after 500 bed volumes the lead concentration was 94.58 ppb; significantly above the discharge criteria for lead of 3 ppb. Given these test results the used of Activated Alumina is not recommended for this site.

2. The **Fine Grained Limestone** was able to reduce the lead concentration to approximately 0.5 ppb throughout the duration of the test with one anomaly. The use of this media meets the discharge criteria of 3 ppb. The mechanism by which the reduction takes place starts with the rise in pH as the water passes through the limestone bed. Lead is least soluble at a pH of approximately 10.0. In this test the pH was raised to approximately 9.5 by contact with the limestone. As the lead comes out of solution it is adsorbed onto the surface of the limestone.

3. The **3/8” limestone** was able to reduce the lead concentration by roughly half. As with the Activated Alumina the lead in the effluent increased over the duration of the test starting from approximately 230 ppb to over 400 ppb. While the pH did increase through the 3/8” limestone bed the total surface area available for adsorption of lead within the 3/8” bed is significantly reduced over that of the fine grained limestone. The fine grained limestone has a surface area of approximately 2,000 times that of the 3/8” limestone in a given volume. Given these test results 3/8” limestone is not recommended for this site.

4. The **3” limestone** was unsuccessful in reducing the lead concentration as there was no reduction in lead concentration through the 3” limestone bed. Given these test results 3” limestone is not recommended for this site.

Wurtsboro Mine Site
Treatability Study Results

Sample	Liters processed	Bed Volumes	Lead (ppb)	Flow Rate (ml/min)	EBCT (min)	EBCT Test Average
Untreated			536.4			
pH = 5.77						
Activated Alumina						
3 Liters	3	38.6	9.18	36.7	6.32	
8 Liters	8	102.8	40.24	38.6	6.01	
13 Liters	13	167.1	43.78	36.9	6.29	
21 Liters	21	269.9	48.68	37.5	6.19	
39 Liters	39	501.3	94.58	37.9	6.13	6.19
Effluent pH = 9.74						
Limestone #16 / #60						
3 Liters	3	54.4	0.45	29.8	7.12	
8 Liters	8	145.0	0.39	23.4	9.08	
11 Liters	11	199.3	1.58	16.8	12.67	
17 Liters	17	308.1	0.45	17.8	11.94	
35 Liters	35	634.3	0.48	17.5	12.12	10.59
Effluent pH = 9.53						
3/8" Limestone						
Untreated - Total Lead			517.2			
Untreated Dissolved Lead			475.4			
3 Liters	3	6.7	231.9	85.0	10.08	
8 Liters	8	17.8	254.7	100.0	8.57	
21 Liters	21	46.8	355.7	104.2	8.22	
39 Liters	39	86.9	383.5	116.3	7.37	
70 Liters	70	155.9	410.4	90.9	9.42	8.73
70 Liters - Dissolved Lead	70		304.3	90.9	9.42	
Effluent pH = 9.74						
3" Limestone						
Untreated - Total Lead			493			
425 Liters	425	7.6	466	14194.5	13.20	
851 Liters	851	15.2	470	14194.5	13.20	
2555 Liters	2555	45.6	474	14194.5	13.20	
4258 Liters	4258	76.0	463	14194.5	13.20	
5962 Liters	5962	106.5	481	14194.5	13.20	13.20
Effluent pH = 9.21						
Minimum Detection Limit			0.12			

Recommendations

Given the test results it is clear that the media of choice is the fine grained limestone for the reduction of lead in the water. We have plotted the media on a grain size curve and have determine the hydraulic conductivity to be on the order of 1,000 – 3,000 gpd/ft^2 . We believe it is possible to design and install an infiltration trench that allows the mine effluent to flow by gravity through the media and reduce lead to discharge levels. We would be happy to discuss this further if you so desire.

Attachments

1. *Reducing Lead and Selenium from Drinking Water Using Limestone-Based Material;* A Thesis present to the Department of Chemistry, Western Kentucky University; Sindhu Tumati, May 2012.

2. Laboratory results from Alpha Analytical dated December 31, 2015

3. Laboratory results from Alpha Analytical dated January 11, 2016

4. Laboratory results from Alpha Analytical dated January 29, 2016

We trust this report is fully responsive to your request. If you have any questions regarding this matter please contact the writer.

Very truly yours
Ground/Water Treatment & Technology, LLC

Robert Kunzel
President and CEO